DESIGN OF ELASTOMERIC BEARINGS FOR BRIDGES - METHOD A

Based on AASHTO LRFD Design Specifications 8th Edition 2017

Client:		**Designed By:**	*Ali Akbar Shaikhzadeh*	**Date:**	*31-Jul-21*
Job Name:		**Verified By:**		**Revision:**	

DESIGN INPUT DATA

DESIGN STATUS O.K.

DEAD LOAD, P_{DL}	450	kN	
LIVE LOAD, P_{LL}	550	kN	
HORIZONTAL MOVEMENT OF SUPER S., Δ_0	25	mm	
AXIS OF PAD ROTATION	Trans.		
CALCULATED ROTATION	0.004	rad.	
ALLOWANCE FOR UNCERTAINITIES ROTATION	0.005	rad.	14.4.2.1
BEARING SHAPE	Rectan.		
BEARING SUBJECT TO SHEAR DEFORMATION	Yes		
BRIDGE DECK FIXED AGAINST HORIZONTAL TRANSLATION	Yes		
BEARING WIDTH, W	380	mm	
BEARING LENGTH, L	350	mm	
ELASTOMERIC LAYER THICKNESS, h_{ri}	10	mm	
THICKNESS OF TOP & BOTTOM COVER LAYERS, h_{cover}	6	mm	
NUMBER OF INTERIOR ELASTOMERIC LAYERS, n_{int}	10		
SHEAR MODULUS OF ELASTOMER, G	0.69	MPa	
YEILD STRENGTH OF STEEL REINFORORCEMENT, F_y	248	MPa	
CONSTANT AMPLITUDE FATIGUE TRESHOLD, ΔF_{TH}	165	MPa	
REINFORCEMENT THICKNESS, h_s	3.17	mm	
CREEP DEFLECTION FACTOR, α_{cr}	0.35		Table 14.7.6.2-1

SHEAR DEFORMATION (14.7.6.3.4)

P_T	1000.00	kN	Total unfactored vertical load	
A	133000	mm^2	Bearing area	
$\Delta_s = \Delta_0$	25.00	mm	Maximum total shear deformation of elastomer at service limit	
$h_{rt} = 2\ h_{cover} + n_{int}\ h_{ri}$	112	mm	Total elastomer thickness (excluding steel shims)	
$h_{cover} \le 0.7\ h_{ri}$	**O.K.**			14.7.6.1
$h_{rt} \ge 2\ \Delta_s$	**O.K.**			14.7.6.3.4.1

COMPRESSIVE STRESS (14.7.6.3.2)

$0.55 \le G \le 1.72$	**O.K.**		Control of shear modulus value	14.7.6.2
$\sigma_s = P_T / A$	7.519	MPa	Service average compressive total load stress	
$\sigma_L = P_{LL} / A$	4.135	MPa	Service average compressive live load stress	
$\sigma_D = P_{DL} / A$	3.383	MPa	Service average compressive dead load stress	
$S_i = \frac{LW}{2h_{ri}(L+W)}$	9.11		Shape factor for rectangular bearing	14.7.5.1-1
$S_i = \frac{D}{4h_{ri}}$	N/A		Shape factor for circular bearing	14.7.5.1-2
$1.25\ GS_i$	7.857	MPa		
$S_i^2 / n < 22$	**O.K.**		**Method A is applicable**	14.7.6.1
$\sigma_s \le 8.62$	**O.K.**			14.7.6.3.2-7
$\sigma_s \le 1.25\ GS_i$	**O.K.**			14.7.6.3.2-8

COMPRESSIVE DEFLECTION (14.7.6.3.3 & 14.7.5.3.6)

In the absence of information specific to the particular elastomer to be used, Equation C14.7.5.3.6-1 or Figure C14.7.6.3.3-1 may be used as an approximate guide for calculating dead and live load compressive strains.

$$\varepsilon = \frac{\sigma}{4.8GS^2}$$ C14.7.5.3.6-1

ε_{Li}	0.0150		Instantaneous live load compressive strain in ith elastomer layer	
ε_{di}	0.0123		Initial dead load compressive strain in ith elastomer layer	
$\delta_L = \sum \varepsilon_{Li} h_{ri}$	1.69	mm	Instantaneous live load deflection (limit is 0.25 inch or 3.17mm)	14.7.5.3.6-1
$\delta_d = \sum \varepsilon_{di} h_{ri}$	1.38	mm	Initial dead load deflection (no limit is defined in AASHTO)	14.7.5.3.6-2
$\delta_{lt} = \delta_d + a_{cr}\delta_d$	1.86	mm	Long term dead load deflection (no limit is defined in AASHTO)	14.7.5.3.6-3
δ_L < 3.17	**O.K.**		Control of maximum relative live load deflection	C14.7.5.3.6

STABILITY (14.7.6.3.6)

h_{rt} < L/3	**O.K.**
h_{rt} < W/3	**O.K.**
h_{rt} < D/4	**N/A**

REINFORCEMENT (14.7.6.3.7 & 14.7.5.3.5)

$h_{s,min}$	1.59	mm	Minimum thickness of steel reinforcement	14.7.5.3.5
$h_s > h_{s,min}$	**O.K.**		Control of minimum reinforcement thickness	
$h_s \geq \frac{3h_{ri}\sigma_s}{F_y}$	**O.K.**		Service limit state	14.7.5.3.5-1
$h_s \geq \frac{2h_{ri}\sigma_L}{\Delta F_{TH}}$	**O.K.**		Fatigue limit state	14.7.5.3.5-2
$n_{steel} = n_{int} + 1$	11		Number of steel shim plates	
$h_{total} = h_{rt} + h_s\, n_{steel}$	147	mm	Total bearing thickness	

FINAL DESIGN SUMMARY

Bearing Width	380	mm
Bearing Length	350	mm
Elastomeric Layer Thickness	10	mm
Thickness of Top & Bottom Cover Layers	6	mm
Number of Interior Elastomeric Layers	10	
Number of Steel Shim Plates	11	
Total Elastomer Thickness	112	mm
Reinforcement Thickness	3.17	mm
Total Bearing Thickness	147	mm